

The assertion, that the angles of refraction are not proportional to the angles of incidence, was an important remark; and if it had been steadily kept in mind, the next thing to be done with regard to refraction was to go on experimenting and conjecturing till the true law of refraction was discovered; and in the mean time to apply the principle as far as it was known. Alhazen, though he gives directions for making experimental measures of refraction, does not give any Table of the results of such experiments, as Ptolemy had done. Vitello, a Pole, who in the 13th century published an extensive work upon Optics, does give such a table; and asserts it to be deduced from experiment, as I have already said (vol. i.). But this assertion is still liable to doubt in consequence of the table containing impossible observations.

[2nd Ed.] [As I have already stated, Vitello asserts that his Tables were derived from his own observations. Their near agreement with those of Ptolemy does not make this improbable: for where the observations were only made to half a degree, there was not much room for observers to differ. It is not unlikely that the observations of refraction out of air into water and glass, and out of water into glass, were actually made; while the impossible values which accompany them, of the refraction out of water and glass into air, and out of glass into water, were calculated, and calculated from an erroneous rule.]

The principle that a ray refracted in glass or water is turned towards the perpendicular, without knowing the exact law of refraction, enabled mathematicians to trace the effects of transparent bodies in various cases. Thus in Roger Bacon's works we find a tolerably distinct explanation of the effect of a convex glass; and in the work of Vitello the effect of refraction at the two surfaces of a glass globe is clearly traceable.

Notwithstanding Alhazen's assertion of the contrary, the opinion was still current among mathematicians that the angle of refraction was proportional to the angle of incidence. But when Kepler's attention was drawn to the subject, he saw that this was plainly inconsistent with the observations of Vitello for large angles; and he convinced himself by his own experiments that the true law was something different from the one commonly supposed. The discovery of this true law excited in him an eager curiosity; and this point had the more interest for him in consequence of the introduction of a correction for atmospheric refraction into astronomical calculations, which had been made by Tycho, and of the invention of the telescope. In